TOPICS INCLUDE

- The threats to space innovation leadership.
- How the Old Space vs. New Space debate is needlessly divisive.
- How to foster unity and innovation within the U.S. space industry.

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A House Divided Cannot Stand: The Need to Unify the U.S. Space Industry

While issues ranging from funding to inspiration threaten innovation within the United States space industry, the world is simultaneously gaining the ability to reach and do business in space – with or without us. This paper describes how unifying the U.S. space industry is the key to surpassing the "Old Space vs. New Space" debate and maintaining America's status as an innovative leader.

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A House Divided Cannot Stand

Space exploration first rose to popularity in the United States as a common goal, meant to unify a country struggling with social and political turmoil and with political-military competition with the world's other superpower. The unity and collaboration that emerged helped drive innovation and extraordinary achievements. Space has since evolved to a hub of business and industry, one of the critical infrastructures driving not only the U.S. but the world.

Today, as other countries develop technologies that reach, operate in and make use of space, America's position as a leader in space innovation is endangered. Paradoxically, the causes of this decline (and discussions of potential solutions) are fueling less a renewed unity of effort in the American space community and more a debilitating "side effect." Established industrial and government space innovators are finding themselves at odds with independent entrepreneurs in a needlessly polar contrast of views about the future of the industry, a debate some see as "Old Space vs. New Space."

In the summer of 2009, Toffler Associates hosted a group of leaders from the public and private sectors to discuss the future of the space industry. The group comprised executives and leaders representing government agencies, non-profit organizations, large multinational corporations, small businesses and major universities and research institutions. Combining their input with our own observations, research and experience, we've developed this paper to help secure the future of the U.S. space industry as a global leader and innovator. Incorporated throughout this paper are some of the thoughts and comments from this esteemed group.

For the U.S. to continue in a leadership role in space innovation, we must unify our innovators (and our industry) so they can work together to address the shortcomings of the current system.

The Importance of Space Innovation

Space is an "invisible" but critical economic infrastructure of our time, already having an enormous impact on both the U.S. and global economies as well as other vital interests like defense and intelligence. That economic role, and the scope and scale of its importance, is often underappreciated. And our country's role as both an economic leader and a beneficiary of space has developed in large part because our space industry historically has been so innovative.

Immediately visible are the direct impacts the space industry has on the economy:

- Space is a $257 billion market (estimated budgets and revenues from public and private sources) that enables commerce, communication, collection of information and more.
- In the commercial space transportation sector alone, the direct valuation is $23 billion, and $139 billion when secondary and tertiary industries are included – more than one percent of the gross domestic product (GDP).

- The industry employs more than 262,000 people in the U.S. and added 12,700 jobs between 2003 and 2007 at pay scales far above national averages.[1]

But these numbers don't begin to take into account the fuller impact the space industry has had on society and the economy. Many innovations derived from the space industry – whether products or processes – have somewhat "invisible" effects. By examining just one innovation – the Global Positioning System (GPS) – we can see a sample of the immensely valuable economic and other effects American space innovation has produced:

- Machine control – In such industries as surveying, construction, forestry and mining, the operational accuracy obtained with GPS receivers has resulted in improved project performance, increased efficiency and preserved natural resources due to reduction in required time, materials and energy.
- Mapping – High-precision GPS combined with other satellites and ground-based augmentation systems has produced more precise mapping, natural resource monitoring, land management and commercial zoning. These improvements have benefited both the economy and the natural resources they measure.
- Timing – Highly accurate timing enables highly effective and efficient execution of many complex functions in the right sequence for applications such as power grid operational management, cell phone network operations, and financial transaction synchronization.[2]

GPS is a common buzzword today, something with which many are familiar even if they don't fully appreciate its significance. But lesser-known space program innovations have had equally important impacts on our economy and progress – for example, the "CORONA" program. Developed and deployed as part of the Cold War, these photographic surveillance satellites (first launched in 1959 and in use for more than a decade) were for military reconnaissance and mapping. In fact, the project helped the U.S. map more than one-sixth of the Earth's land surface at a medium scale. CORONA imagery, declassified as recently as 1995, was found to have spatial resolution far superior to civil remote sensing systems of the 1970s and even 1980s. Today, this bank of imagery is helping meet our nation's objectives to recognize, measure and assess global environmental changes by extending backward our ability to analyze environmental change timelines and filling gaps in civil records. Moreover, without the pioneering CORONA technology development, we would not have the even more accurate commercial satellite imagery now routinely being used for applications related to resource management, agriculture, forestry and archaeology, with the potential for additional uses in the social sciences.[3]

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[1] The Space Report 2009, The Space Foundation, Colorado Springs, CO
[2] Toffler Associates interview with commercial space industry executive
[3] Robert A. McDonald *, Potential New* Applications *for Declassified Early* Satellite *Reconnaissance Imagery*, CIA Cold War Records: CORONA: America's First Satellite Program

The Threats to Space Innovation Leadership

Clearly the U.S. has been an innovative force in space, allowing us to drive the progress of global society. But our future as innovators – and, therefore, as leaders – is threatened. And some of our problems are internal, risking a downward spiral as threats (bureaucratic slowing of processes, unclear goals, increasing competition, diversion of motivated talent to other fields, lack of funds, etc.) feed on each other.

What we're seeing is a growing desynchronization between the pace of change in technological evolution and the system of processes and infrastructure in which that technology development occurs. The ability to innovate is increasing faster than the environment can support. Currently, the field is populated predominantly by what we might call "traditional space players" such as the Department of Defense, the intelligence community, other government users, and the large corporations that serve them. The business processes intrinsic to these organizations (requirements and regulations surrounding acquisition, R&D, safety, security, resource management, etc) are becoming more of a hindrance than a support mechanism when it comes to innovation.

> "I think we're going to figure out that we need to get to space when it's too late. I think there will come a time when all of a sudden we'll realize we are two decades behind where we need to be. And so I think it's up to us to demonstrate to the world and humanity that this is the single-most important piece of risk management that we could possibly endeavor."

Looking at the threats to space innovation leadership reveals this desynchronization trend.

- Competition between the U.S. and foreign markets – In the past decade, 15 new countries now own satellites with spacecraft of their own, an increase of approximately 50 percent. And nations such as South Korea, Iran and Pakistan are fielding independent launch systems – the number of foreign states capable of launching their own spacecraft is expected to double from the half-dozen with the ability only 10 years ago.[4] These achievements show a clear advancement in technology, all or mostly without the contributions of the U.S.

  Some of these cases represent missed opportunities for our domestic commercial space enterprises. A primary barrier is regulatory, most specifically the International Traffic in Arms Regulations (ITAR) that control the export and import of defense-related articles and services on the United States Munitions List (USML). As a result of the fairly recent inclusion of satellites and related components and materials on the USML, some argue it's become far more difficult for U.S. companies to do business with non-U.S. customers, even friendly nations such as the U.K. or Canada.

[4]Scott Larrimore, "International Space Launch Notification and Data Exchange," Space Policy. Vol. 23 (August 2007): 172-179

While security concerns are real in an era of "rogue" nations and others looking to space, "cyberspace," and other domains as venues and means for waging war, our increasingly cumbersome system for reviewing and updating these restrictions doesn't allow us to play effectively in the marketplace to meet the technological needs of appropriate foreign buyers. These buyers are turning to other sources to supplement their own breakthroughs, limiting the near-term economic opportunities for our commercial organizations. This in turn reduces the revenue and profit available to plow back into cutting-edge R&D to retain and strengthen our position as space industry innovation leaders.

- Funding – Domestically, funding has both declined and become tangled in complex acquisition and procurement processes that result in decades-long cycles of innovation (i.e., getting ideas from the labs to the skies). "Patronage" of the space industry by U.S. civil government has declined considerably over the past 15 years. Last year, the NASA Administrator noted the agency's budget was down 20 percent in inflation-adjusted terms since 1992. For all that the agency would like to accomplish (sustain the International Space Station, travel to the Moon and/or Mars, replace the Space Shuttle, and more), it faces a $50 billion budget shortfall.

> "Why isn't there more activity in space? What's the next great mission? …When a ham sandwich is $10,000 in lower orbit, that's an expensive meal, and that kind of constrains what you can do. What is the next killer app in space? …In near-Earth space there may not be a next killer app. There may be more things done and if you could do them more cheaply, maybe more people would do them."

While space spending in the Defense Department has been rising considerably, DoD's space acquisition processes continue to result in major cost and schedule overruns. The funding process has a perverse effect on innovation – because acquisition programs crowd out R&D programs aimed at "proving" emerging new technologies, DoD space efforts tend to move forward before we are confident the desired capabilities are achievable on time and on budget. This too often leads to integration and other problems that developers must address urgently, diverting money and time from the true innovations we want and need. Other aspects of the acquisition process – for example, tolerating the addition of new requirements well into the acquisition phase, and the large (and ever-morphing) array of organizational entities involved – add other complications that make it difficult for industry to innovate at the speed and with the effectiveness it once did.

By contrast, other nations (for example, Russia, Japan, China, members of the European Union) are boosting their space spending, some of them in programs and processes that don't necessarily bear many of the complexities attached to allocating and spending money in the U.S. system.[5]

[5]Marc Kaufman, "U.S. Finds It's Getting Crowded Out There," Washington Post, July 9, 2008

- Launch costs – Some argue that the cost of launch (more than $200,000 per pound) is a primary inhibitor of innovative breakthroughs in the exploitation of space, and that this is due, in part at least, to the cost of complying with multiple layers of regulations (or, in the view of some, "red tape").

  Relative launch costs increasingly are a pivotal part of global space industry competitiveness and innovation since many advances are tied to the ability to perform experiments in space. A study by Futron reported that the U.S. is losing its dominance in orbital launches and satellites built. In 2007, only 53 U.S.-built satellites were launched (accounting for approximately 50 percent of global launches) versus 121 in 1998. A decade ago, U.S. companies also commanded nearly two-thirds of the world's satellite manufacturing market, but by 2007 that share had dwindled to 41 percent. A growing number of voices in and around the space industry argue there is a direct correlation between these phenomena and high launch costs, pointing to complex regulation and related processes as a driving factor. Some specifically attribute the decline to ITAR constraints and the consequent loss of customers U.S. companies were prohibited from seeking.[6]

  Safety regulation processes are at issue as well, even despite attempts to streamline the licensing of commercial launches through development of common FAA – Air Force safety standards and acceptance of each other's waivers of specific licensing requirements. Illustrative of the problem is the fact that the "Licensing and Safety Requirements for Launch Final Rule," published in the Federal Register in August 2006, weighs in at more than 200 pages and took more than six years to complete.[7]

  > "We operate in silos in space; we're stovepiped. If we spread the space capability across the U.S. government and require agencies to say how they can utilize it [space], how they can benefit from it against their requirements, I think we would have a different kind of space enterprise that we have now."

- Diminution of talent – Numerous sources bemoan how the number of persons entering "STEM" fields (science, technology, engineering and mathematics) has definitely slowed in the last half-century. According to Michael Griffin, former NASA Administrator, "almost twice as many bachelor's degrees in physics were awarded in the United States [50 years ago] than in 2004." Echoing the assessments of many other in academia, policy, business and elsewhere, Griffin also notes that American students are falling behind their peers in other industrialized nations in math and science. And, "in 2000, 38 percent of technology PhDs was conferred upon foreign-born graduate students, most of whom return to their home countries."[8] Historically, more tended to remain in the U.S., some becoming citizens and many pursuing careers as technology developers in industries including aerospace, or as technology entrepreneurs. This

[6] Ibid; also Sandra Erwin, "Export rules under fire for eroding U.S. space industry," National Defense, June 2009
[7] Federal Register, Vol. 71, No. 165, August 25, 2006, Rules and Regulations
[8] Michael Griffin, Remarks to Calvin College, January 17, 2008, www.nasa.gov/pdf/208781main_Calvin_College_080117.pdf

decrease and loss of talent affect both our ability to innovate and to lead progress in the space industry.

- National inspiration – The unique nature of our social-political dynamic in the U.S. has had its own retardant effect on those looking for motivation from "our country" for innovation related to space technology and space exploration. With conflicting and shifting priorities among our nation's leaders, a common goal or vision (like the ones that sparked the rise of the industry in the 1950s and 1960s) is difficult to discern.

> "I'm still struggling to find the 'have to go to space' reason. Where we need to get our heads to is the people who really don't want to go there but have to, have no choice."

Both Presidents Obama and Bush and their teams have sought to find an inspirational objective in space that will rally the nation's imagination and channel its energies. While the idea is valid, practical efforts are colored by the very nature of our democratic (and thus often conflicted) political system. There's been lack of agreement on a rallying point. Is the ultimate goal space flight or space exploration? For space flight, shall we pursue a shuttle or something else? Will we continue to participate in the ISS or not – and to what end? In exploration, is it back to the moon, a manned exploration of Mars, or both? Some argue that exploration itself needs to take a back seat to more "practical" missions such as climate monitoring and earth protection. And some argue for a smattering of all of the above, "prioritizing" everything and thereby prioritizing nothing.

Our inability to crystallize a unifying goal increasingly leaves innovators with a conflicted vision of how their efforts in the space industry can serve a purpose.

"New" Innovators, Same "Old" Problems

It should be no surprise that a so-called "New Space" community has emerged. Some of the entrepreneurs working on new space launch services and other space-related ventures are doing so out of ardor – the sheer personal commitment that has driven many of history's great, high-impact innovations. But some are reacting to the threats and barriers that have slowed innovation and, in this sense, increasingly seeing themselves as a community fundamentally contrasted with the traditional industry. Since concern about our relative decline as space innovators is at the center of the growth of "New Space," a growing number of observers are impelled to disparage "Old Space." This frustration increases as New Space players more and more find themselves affected by some of the systemic problems from which they wish to be free.

> "One of the main issues is the way we currently put roadblocks up in front of business attempts in space, having now done it myself. The red tape was basically insurmountable. The costs were insurmountable, and also unjustifiable…"

The emergence of the New Space movement is in fact traceable directly to the threats we've described for innovation and leadership. Most of the New Space players are entrepreneurs (independent individuals and/or commercial entities) that view themselves as capable of advancing progress by going outside the current system and, therefore, around the barriers. And they do demonstrate some important differences relative to the traditional space industry:

NEW SPACE PLAYERS

While perhaps there are no definitive criteria on exactly who constitutes a "New Space" player, the following individuals are regarded as some of the core members of the "movement."[1]

- Peter Diamandis has founded companies in the space tourism business, including Space Adventures, which takes private citizens to the International Space Station. Also founder of the X Prize, which offered $10 million to the team that could put a pilot in orbit.
- Paul G. Allen, a founder of Microsoft, paid for SpaceShipOne, the tiny craft that won the X Prize in 2004.
- Burt Rutan is the founder of Scaled Composites, which designed and built the SpaceShipOne suborbital commercial spacecraft financed by Peter Allen.
- Richard Branson, founder of Virgin Air and Virgin Galactic, will buy additional composite spacecraft from Scaled Composites for Virgin's space tourism business.
- Elon Musk, a founder of PayPal, is developing rockets through his company, Space Exploration Technologies (Space X), and has NASA financing that could lead to his spacecraft's carrying people and supplies to International Space Station.
- Jeff Bezos, founder of Amazon.com, is developing rockets at a site he owns in Texas and is building up Blue Origin, another commercial space company aiming to reduce the cost of flight for citizens through a new vertical take-off/landing vehicle.
- Robert Bigelow, who made his fortune in hotels, is developing a space transportation system and a space station that could be used as an orbiting hotel or a research base.
- Larry Page was co-founder of Google and is an X-Prize sponsor.

- Foreign competition – New space players are more inclined, to the extent regulations and other factors allow, to follow open innovation principles, seeking to collaborate with foreign space entities (commercial and government), as well as other entities outside the space domain, to fuel ideas and progress.

- Funding – Many individuals and small companies are drawing start-up money from commercial industries well outside aerospace, such as the Internet and information technology world (see sidebar) and from the debt and equity markets.

- Launch costs – While the space economy broadly includes hardware (launch vehicles, satellites, etc.) and services, and space launch thus is only one component of the commercial space industry, many of the New Space players are focused primarily or solely on "fixing" the launch problem, developing new technological approaches and, in the meantime, taking advantage of competitive launch services available from foreign providers to launch experimentation missions and other potentially profitable cargoes.

- Diminution of talent – While the effect of New Space on the roots of the larger "STEM" education issue in America is not yet clear and may be impossible to assess, it's clear these independent, innovative groups are attracting some talent from the shrinking pool currently available in the U.S. (i.e., drawing innovators away from "Old Space" players).

- National inspiration – The New Space innovators seek to create their own sources of inspiration, perhaps in part because they don't feel strong enough motivators from the government or other traditional sources. The Ansari X Prize is perhaps the most well-known example of an inspiration created "by and for" New Space.

Yet while New Space success has been growing, it has encountered its own challenges, some of which are seen by traditional industry players as barriers to New Space's long-range sustainability:

- An unrealistic or unsafe vision – Some are concerned that new launch system designs are not fully formed and tested. From this perspective, migrating to a model that depends more heavily on private industry and investment is imprudent at this time. Emblematic is the view expressed in a recent op-ed by 16 former astronauts that NASA's currently-planned "Constellation" architecture for space exploration is "infused with generational lessons learned, well planned and scrutinized by multiple stakeholders to provide a safe and reliable system" while "new entrants to the aerospace community" could "possibly" be a viable option. The panel convened by President Obama to assess options for future space exploration has said that "while it presents some risk… commercial services to deliver crew to low-Earth orbit are within reach." But others point to failed launches by Space X spacecraft and the tragic explosion at Scaled Composites that killed three to suggest that NASA neither will nor should be eager to send astronauts into space on a rocket developed outside the traditional agency development paradigm.9

- A limited goal – Some of the New Space entrepreneurs may be focused only on more immediate goals (primarily revolving around the space launch business) that may result in quicker commercial payoffs (through such eventual outlets like space tourism) but which will ultimately do little to progress innovation for the larger space industry.

- A limited funding stream – While "prizes" currently help spur both funding and motivation, these private funds could cease either by choice or due to the debt/equity markets, while government funding tends to be more stable over time.

Unity as the Key to Success

American space innovation will continue to face both "old" and "new" threats if the traditional industry and the entrepreneurs continue to see themselves as fundamentally different camps instead of as different voices and approaches in the same system. Unifying these minds, goals, processes and inspirations is not a naively optimistic objective. It's a necessity in an environment in which our goals in space are becoming more diverse and challenging to achieve, competition with other economies and powers more intense, and our need for a diversity of technical and managerial solutions more critical than ever before. An "us-vs.-them" mentality is a red herring and ultimately

[9] Houston Chronicle, August 30, 2009; Review of U.S. Human Space Flight Plans Committee, report summary provided to Director, White House Office of Scienc and Technology Policy (OSTP) and NASA Administrator, September 8, 2009

counter-productive – Old Space and New Space are the U.S. space industry of the future and only together can the country create a sustainable path to space innovation and leadership. A divided industry diminishes our ability to focus on the elements that proactively foster innovation, effectively address the threats to our space innovation leadership, and develop an effective long-term strategy for space exploration and a space economy.

Space innovation, like any innovation, results from the alchemy of competition, money or patronage, talent, and inspiration. Where one of these is lacking, innovation is bound to suffer. And when we have a diversity of approaches to and perspectives on each element, innovation will thrive. In Toffler Associates, we believe some simple steps can help the two sides of the space community come together to address the challenges and opportunities in the core elements that comprise and fuel innovation:

> *[in reference to sending more business into space]* "I heard a long time ago: 'Often countries with abundance ignore the resources that they have' – and I think that applies here."

- Talent – A unified industry should help current innovators make the best use of their talents and inspire future innovators to become involved. It's no accident that many of the New Space entrepreneurs come out of the Internet, information technology, interactive gaming and other related worlds (see sidebar). Those are industries in which innovation has been immense in the last few decades, while the nation's space vision has floundered and its traditional government-industry space community has labored under the processes we've discussed. Numerous analyses of the "STEM crisis" in American education point to these industries as the "competition" absorbing the dwindling number of engineers and other technical geniuses that a generation or two ago would have seen a compelling future in the aerospace business.

  With how we go to space and what we do in space changing – as they must – Old Space and New Space working together can create opportunities to entice the best talent our nation produces to devote themselves to those pursuits. For example, if defense agencies and other users of space embrace architectures of smaller, simpler, more numerous systems alongside traditional large-scale multi-mission platforms, we can address a clear disincentive to many young people who consider careers in the space industry but don't pursue them because they know it would take years or even decades to see their work come to fruition. The growing knowledge and knowledge-integration component in robotic and other "non-traditional" space systems is also an obvious draw for young people who might otherwise look to Internet or other computer and communications fields.

- Inspiration – The U.S. government and industry – the whole space industry, "Old" and "New" – need to work more closely together to define a vision and strategy for the future. Right now, the vision for space is unclear – the what, the how, and certainly the why. More than anything else, government and industry leaders need to assess the nation's interest(s) in space. The previous presidential administration tried to address this by advocating for a return to the moon and later manned flights to Mars. The new administration is considering the same goals as well as others. But

too often, too many treat the "other" goals as secondary, frivolous or merely mercantile.

A truly unified future vision for space must consider that, for some, the moon is "been there, done that" and even Mars is perceived as a goal already reached by the rovers. For a "New-Old" vision to inspire all Americans, it must speak more directly to what motivates all of them, encompassing things such as environmental concerns, "extreme tourism," and the opportunity to make a fortune in a literally blue-sky market.

- Money – For a long time, the U.S. commercial space market has depended on the national government to carry the burden of financing for space projects. This is on the decline and will not likely reverse in the near- to mid-term, especially given the specter of a $9 trillion deficit. Government funding for space exploration and innovation won't go away, nor should it. But U.S. capital markets also are eminently capable of massing the financing that contributes to innovation, given clear projects or line items where that funding should be directed. In the absence of obvious compelling business cases (or common national goals), these directions need to be determined by vision and strategy.

  The two sources of funding need to work together, not one type of money for one set of "visionary" goals in space (Moon, Mars, exploration, etc.) and the other type for other "mercantile" goals. Ultimately, the national goals must be in business case terms, and the business cases can and should be synonymous with our national goals for space. To that end, the future government-industry national space strategy should employ a needs-based approach. Likewise, commercial companies should review and revise their market strategies to track with this strategy and set of needs.

- Competition – The U.S. government must let the nation's space community play without needless handicap in the global arena of ideas and competitive commerce. Regulatory oversight is often targeted, and rightly so, as the key government-controlled impediment to space innovation. ITAR is only one element of this. Other impediments include the complexity of the safety and other certification processes for launch and the architectures of government-to-government agreements (for example on unrestrained and uncompensated sharing of data collected by government-owned and -operated satellites).

  Historically, the government could compensate companies while modulating competition through regulation and contract awards. As conditions reduce the government's ability to patronize the industry with one hand (resources), it must loosen its grip with the other (regulation) if we want innovation to thrive. In particular, government needs to radically reconsider the paradigm for restricting what space-related technologies (and underlying ideas) companies can trade in. This is particularly important in an era in which the idea of restricting the "movement" of knowledge from place to place is increasingly chimerical. At the same time, New Space enterprises must continue to appreciate the importance of security given the growing challenge of knowing who ultimately might obtain advanced technologies and exploit them to desperate ends.

Conclusion

Just as pressure combines with the elements of heat and carbon to create a diamond, there are similar “pressures” that combine talent, inspiration, money and competition (and other elements, to be sure) to foster innovation. The waxing and waning of each of these elements is what creates the pressures, and today there are many gripping the U.S. commercial space market. One is the downward spiral of governmental investment. Another is the volatile competition caused by an increasingly globalized marketplace. Yet another lies in the battle for mindshare among each next new generation of technical and entrepreneurial talent.

Commercial space companies both “old” and “new” must recognize that these pressures are a necessary, if sometimes uncomfortable, force that fuels their innovative potential as much as threatening it. Government must recognize it as well, for it faces many of the same challenges. Some ideas, businesses and even agencies will fail to survive and others will thrive. Some foreign entities will get “American” business, and some “national” goals will be achieved only through collaboration with partners outside our borders and fellow innovators outside the space industry. If we resist or oppose such pressures and their outcomes, we jeopardize the very stuff of innovation. And if we oppose each other within the space community, we do the same. To secure our future as leaders in space innovation, “old” and “new” players must unify their efforts, rising above divisive labels to collaboratively surpass both internal and external threats. Only together can we effectively embrace the pressures that foster innovation and create a sustainable infrastructure that will support our progress in space.